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TRANSMITTANCE MEASUREMENTS AT DIRT-III
A PRELIMINARY REPORT

MARCH 1981

By

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This preliminary report describes the visible and infrared transmittances measured through dust clouds and rain at the Dusty Infrared Test-III (DIRT-III), Fort Polk, Louisiana, April-May 1980. The measurement system was the Naval Research Laboratory (NRL) transmissometer operating at 0.55, 1.06, and 10.37 micrometers.

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20. ABSTRACT (cont)

Data were collected through dust clouds produced by various types of munitions and high explosives in the natural soil and tailored soils consisting of sand, silt, clay, and various mixtures.

The onset of a rainstorm also provided the opportunity to measure transmittances for varying precipitation rates.

A complete data report will be published later.

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This is a preliminary report on the Naval Research Laboratory (NRL) experiments at the Dusty Infrared Test-III (DIRT-III) tests at Fort Polk, Louisiana, in April-May 1980. The NRL experiment was designed to measure spectral transmittance through smoke and dust clouds generated by static detonations of various explosive charges in natural and prepared soils. Spectral transmission data as a function of time were obtained for 82 events.

The transmissometer used in the DIRT-III tests consisted of a source, receiver, and associated recording and data processing equipment. A 600-watt halogen-filled narrow filament tungsten lamp in a 24-inch diameter searchlight served as the source. The beam width of the searchlight was 20 milliradians. Filament emission provided energy at 0.55 and 1.06 micrometers, while the quartz envelop at 1000°C provided energy at 10.37 micrometers. Radiations were modulated at 750 hertz by a mechanically driven slotted chopper cage.

The receiver assembly consisted of a two-detector section for 0.55 and 1.06 micrometers and a coaxial section for 10.37 micrometers. The two-detector section consisted of two Si detectors, filters, and beam splitter; each detector had a field of view of 0.6 milliradian, equivalent to a field of about 52 centimeters diameter in test area. An HgCdTe detector at the focus of a 60-centimeter diameter, f/2.3 mirror detected 10.37 micrometers radiation. The filter spectral half bandwidths were: 0.55 micrometer to 8 nanometers, 1.06 micrometers to 0.01 micrometer and 10.37 micrometers to 0.15 micrometer. Leg supports resting on the ground decouple the receiver assembly from all trailer motion.

The transmitter source was located at the northeast end of the optical path, 0.87 kilometer from the receiver. All detonations took place in a 140- to 150-meter area between receiver and transmitter sites. All data were obtained as the dust and smoke clouds moved through the optical beams about 5 meters above ground.

The recording equipment was started at -3 minutes to determine the 100 percent and 0 percent transmission signal levels. Turnoff after the event occurred when the 100 percent level was reestablished, for most events at about +2 minutes. The data were sampled and processed in real time once each second, printed on paper tape and stored in the calculator memory, and recorded on magnetic tape. Some graphs of transmission data are included in this report. We estimate the accuracy of the transmittance measurement to be about ± 5 percent. Data for all shots will be included in the final report to be published later.

Useful transmittance data were obtained for 82 events: 41 in natural soil and 41 in prepared soils. The prepared soils tested consisted of sand, silt, clay, and various combinations. Tabular listings of transmittance versus time were developed and will be included in the final report. This preliminary report contains spectral transmittance curves for selected events representing various soils, charges, and meteorological conditions. In most events the 1.06-micrometer data are similar to the 0.55-micrometer data.

The following data are representative of DIRT-IIIA and IIIB.

A-4, A-5, A-6 (Figures 1, 2, 3) Surface Tangent Buried (STB)

These tests were all in wet, natural soils. Most of the data show that infrared at 10.37 micrometers has lower transmission than visible or 1.06 micrometers.

A8 155-Millimeter Shallow Buried (SB), 18 April, 1716 GMT (1116 CST) (Figure 4)

This charge was buried in wet, natural soil. The transmission curves are unusual in that in the early data when the cloud sample had a high content of wet soil the 10.37 transmittance is less than visible. Beyond +7 seconds where the cloud sample is mostly smoke, the infrared is greater than visible.

B-1 105-Millimeter ST, 16 April, 1935 GMT (Figure 5)

This event was a surface charge in dry surface, natural soil, wet subsurface, on the optical axis. Excellent data were obtained for about 100 seconds. Infrared transmission is greater than visible for the entire run.

C-6 Composition 4 (C4) SB, 21 April, 1912 GMT (Figure 6)

This event was a buried shot in low wind conditions, dry surface soil. Transmittances at 0.55 and 1.06 micrometers are similar, as shown in the figure. Data were obtained for about 110 seconds.

D-2 122-Millimeter ST, 15 April, 2059 GMT (Figure 7)

This event was a surface shot in calm conditions in natural, dry surface soil, wet subsurface. Data were obtained for about 100 seconds. The data are typical for dry soil and smoke clouds where infrared transmittance is greater than visible and 1.06 micrometers.

E-5 155-Millimeter STB, 21 April, 2258 GMT (Figure 8)

This event was a buried shot in calm conditions in natural soil, dry surface, wet subsurface. Data were obtained for about 250 seconds. Infrared transmittance was lower than visible or 1.06 micrometers for about 65 seconds. Beyond this point, the cloud sample consisted of smoke and dry dust so that infrared transmittance was greater than visible or 1.06 micrometers.

TS-21 Dry Sand 5 pounds, 29 April, 1837 (1337 CDT) (Figure 9)

This shot consisted of 5 pounds of explosives on a prepared soil of dry sand. Data show similar transmittances for visible and infrared.

TS-27 Wet Silt 5 pounds, 1 May, 1808 GMT (Figure 10)

This shot consisted of 5 pounds of explosive on a prepared soil of wet silt. Data show similar transmittance for visible and infrared for about +35 seconds. From this point to about +80 seconds, visible transmittances are a few percentage points greater than infrared.

TS-42 Dry Sand and Silt 5 pounds, 1 May, 1741 GMT (Figure 11)

This shot consisted of 5 pounds explosive on a prepared soil of dry sand and silt. For most of the time, the infrared and visible transmittances are equal.

Event R-12 (Figure 12)

Figure 12 shows transmittances through rain for about 6 minutes beginning at 1858 on 17 April. Observations were interrupted at +430 seconds because of equipment failure. The data show that infrared at 10.4 micrometers has lower transmittance than either visible or 1.06 micrometers.

Event Rain 3 (Figure 13)

Figure 13 shows rain transmission data after equipment repair on 17 April beginning at 1938 for about 1 hour. The figure indicates a brisk shower at about +1600 seconds where 10.37 micrometers transmission has a minimum value of 25 percent or about 1/2 the corresponding visible value. There is an unusual occurrence here in that infrared is greater before the shower and generally less after the shower has passed through.

Event R-4 (Figure 14)

Figure 14 shows a higher time resolution of transmittance during the shower in Event Rain 3.

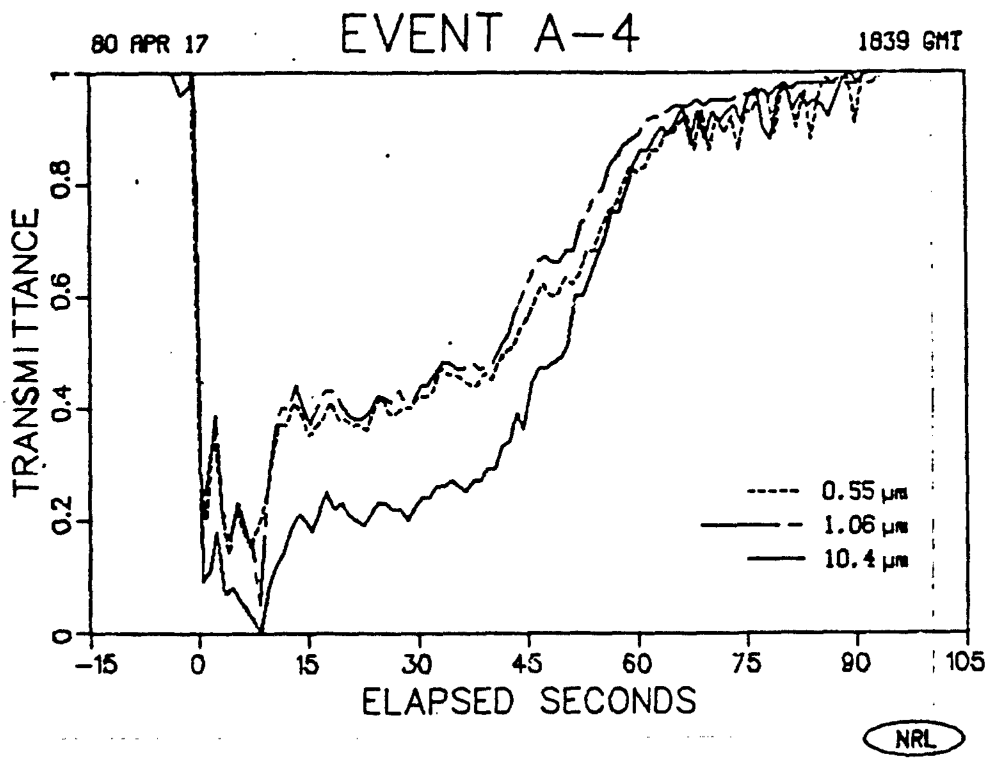

Figure 1. Test A-4, 155-millimeter projectile, STB, on axis.

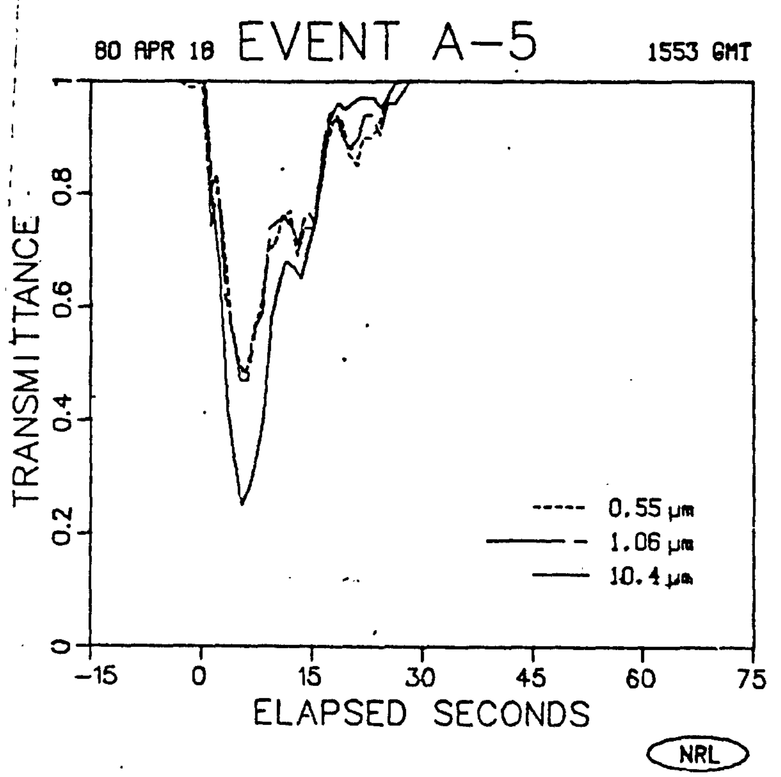

Figure 2. Test A-5, 155-millimeter projectile, STB, 10 meters off axis.

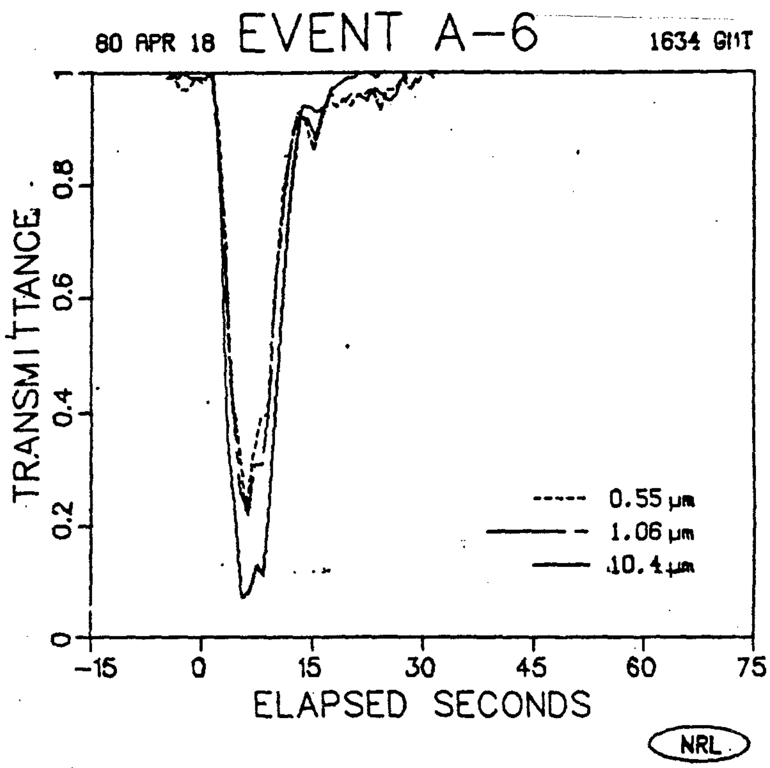

Figure 3. Test A-6, 155-millimeter projectile, STB, 20 meters off axis.

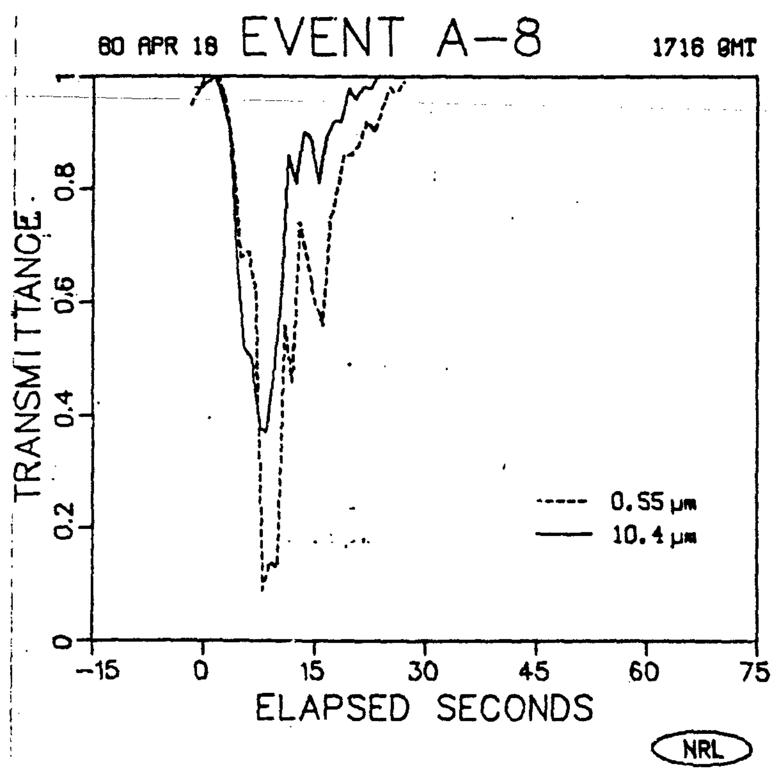

Figure 4. Test A-8, 155-millimeter projectile, SB, 20 meters off axis.

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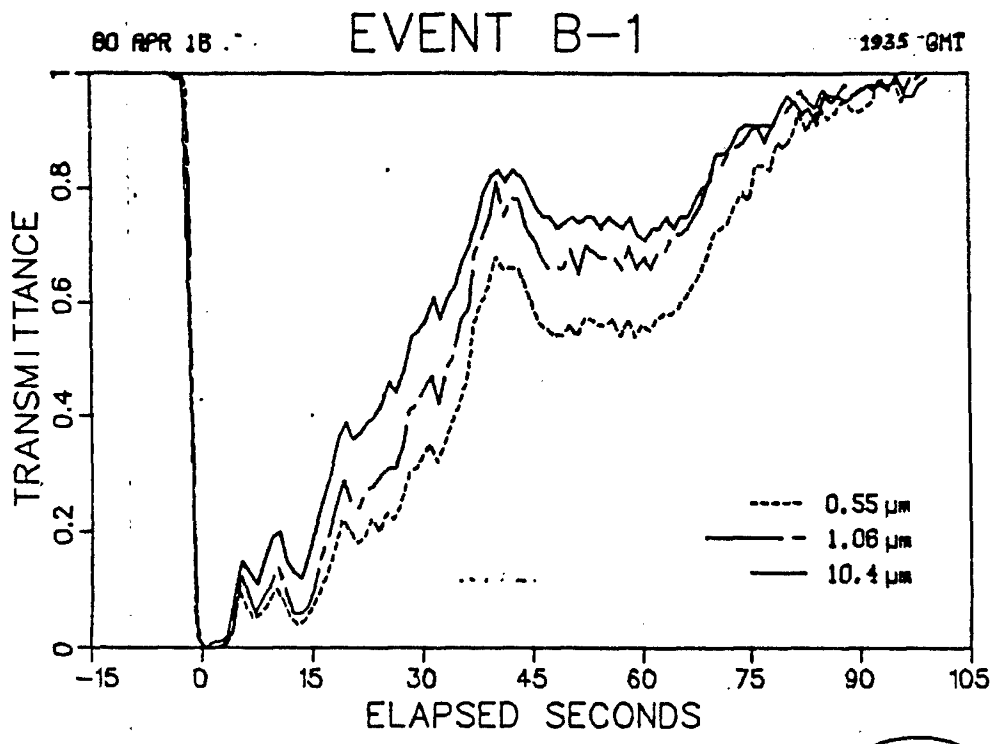

Figure 5. Test B-1, 105-millimeter projectile, ST, on axis.

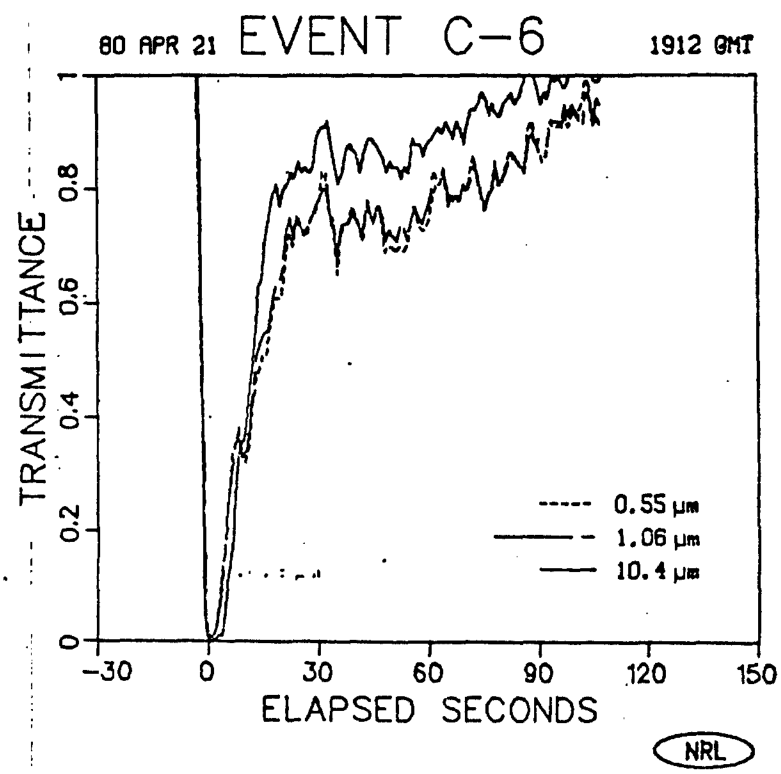

Figure 6. Test C-6, C4 high explosive, SB, on axis.

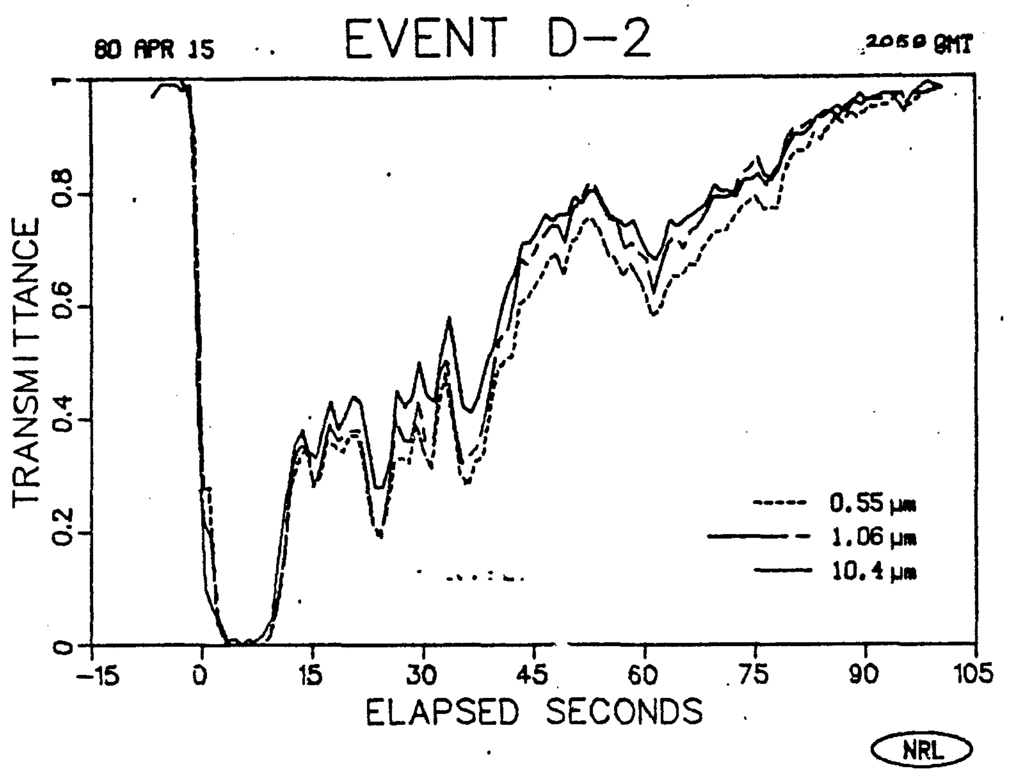

Figure 7. Test D-2, 122-millimeter projectile, ST, 10 meters off axis.

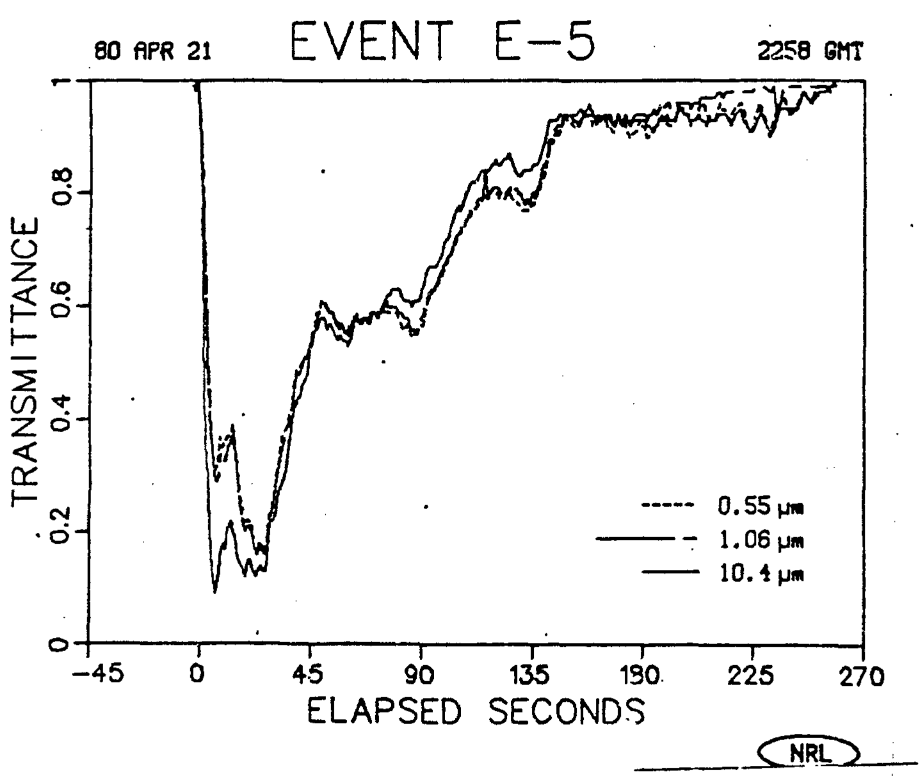

Figure 8. Test E-5, 152-millimeter projectile, STB, 10 meters off axis.

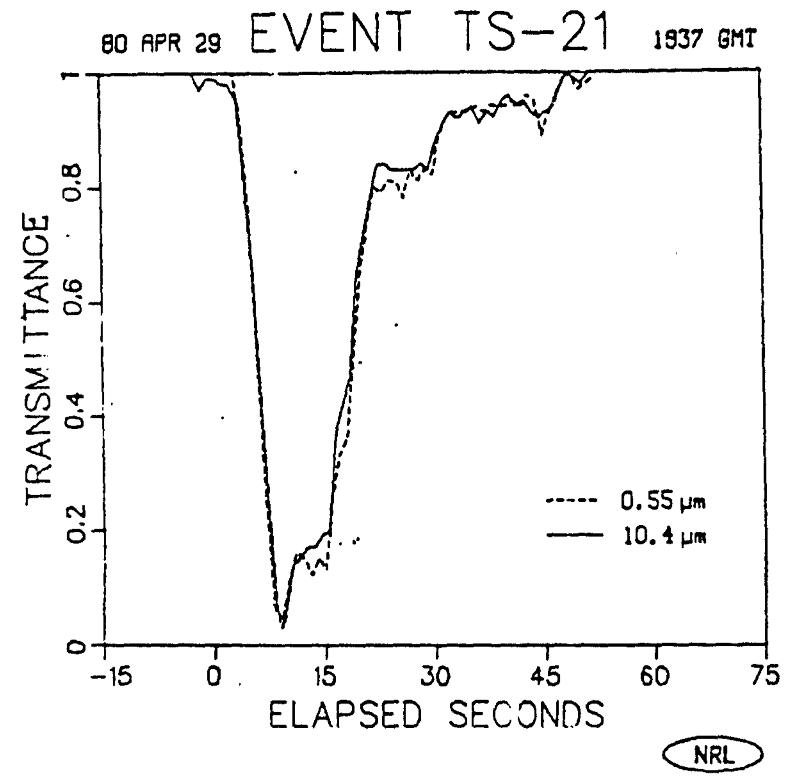

Figure 9. Test TS-21, dry sand, 20 meters off axis.

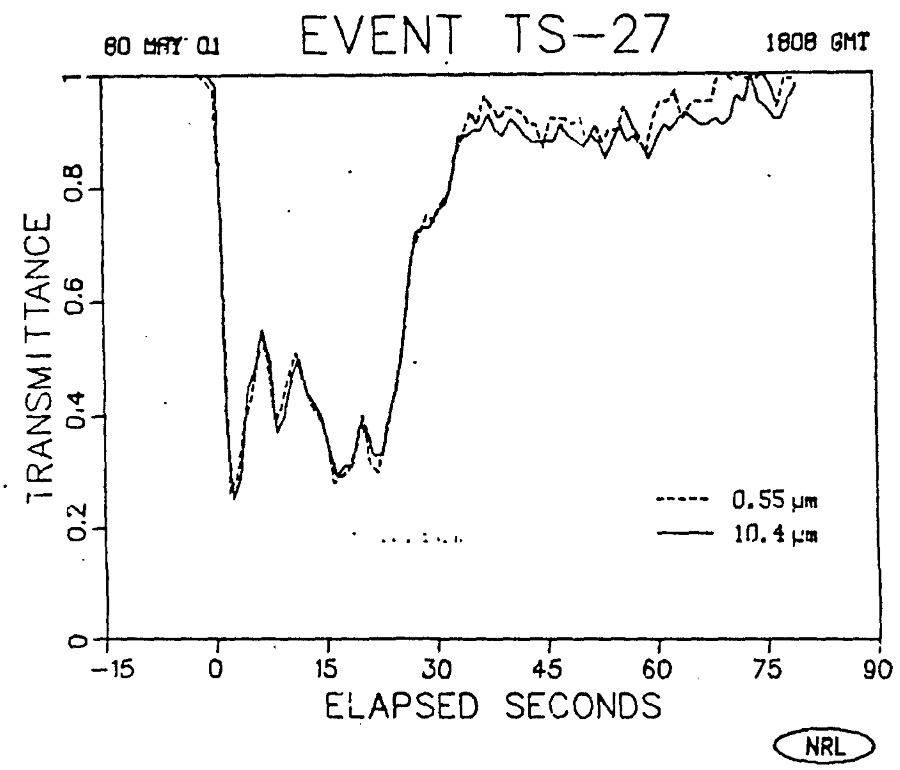

Figure 10. Test TS-27, wet silt, 10 meters off axis.

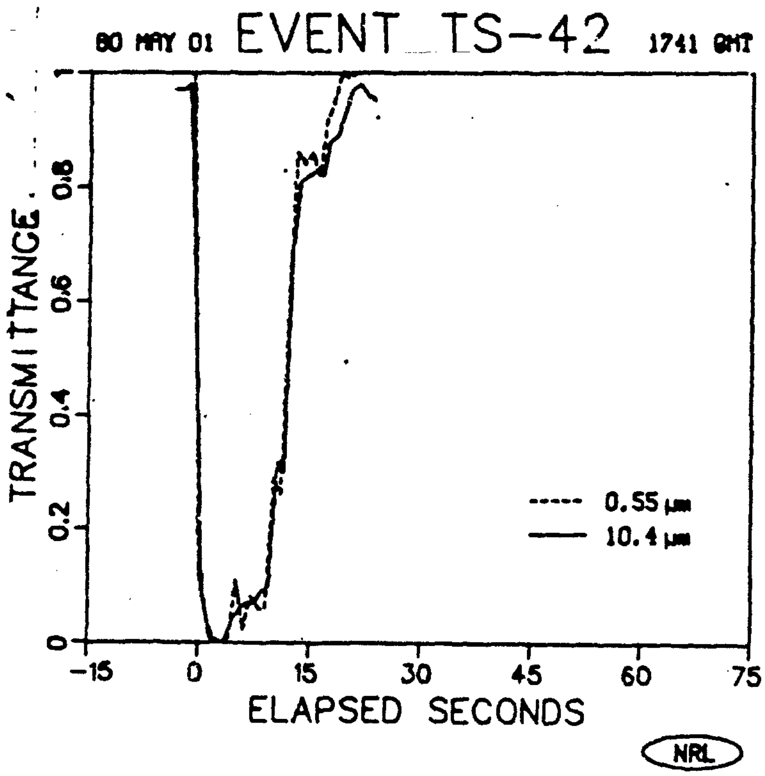

Figure 11. Test TS-42, dry silt and sand, on axis.

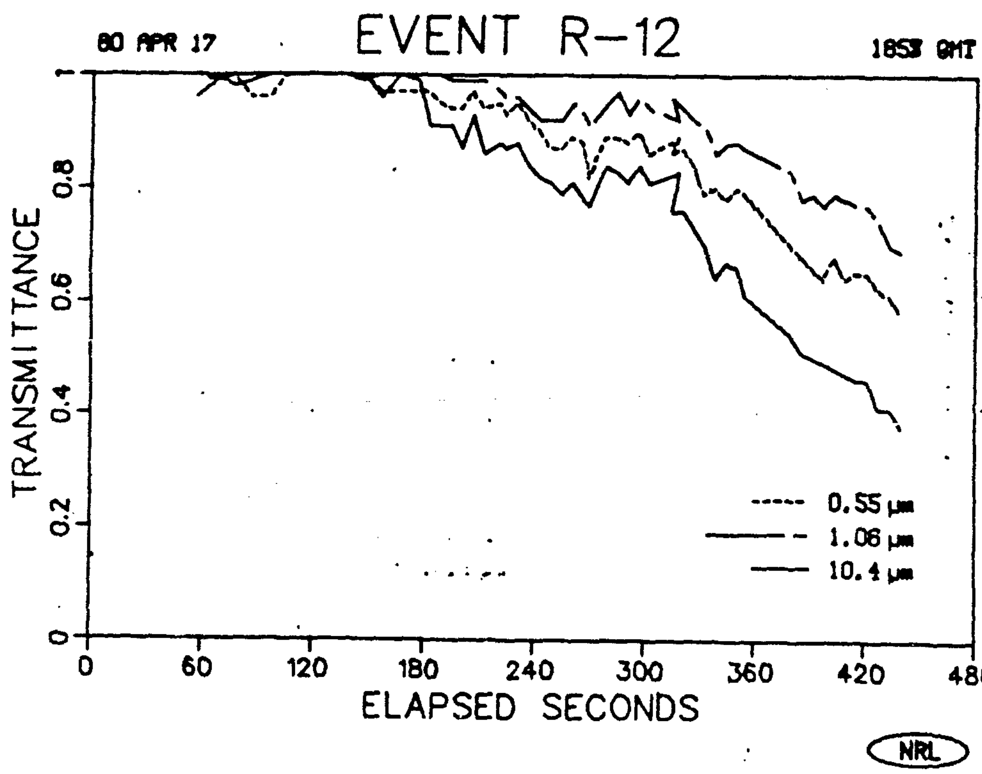

Figure 12. Transmittance measured during onset of rain.

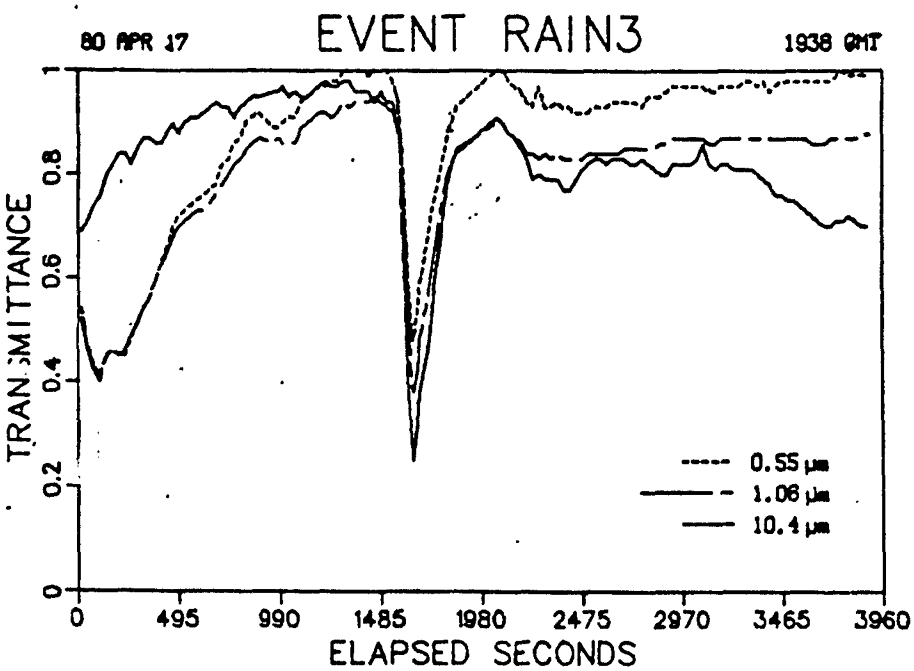

Figure 13. Transmittance measurements after equipment repaired. Note the periods of low transmittance corresponding to heavy precipitation periods. The 0.55 micrometer and 10.37 micrometers reversed positions during the last heavy rain.

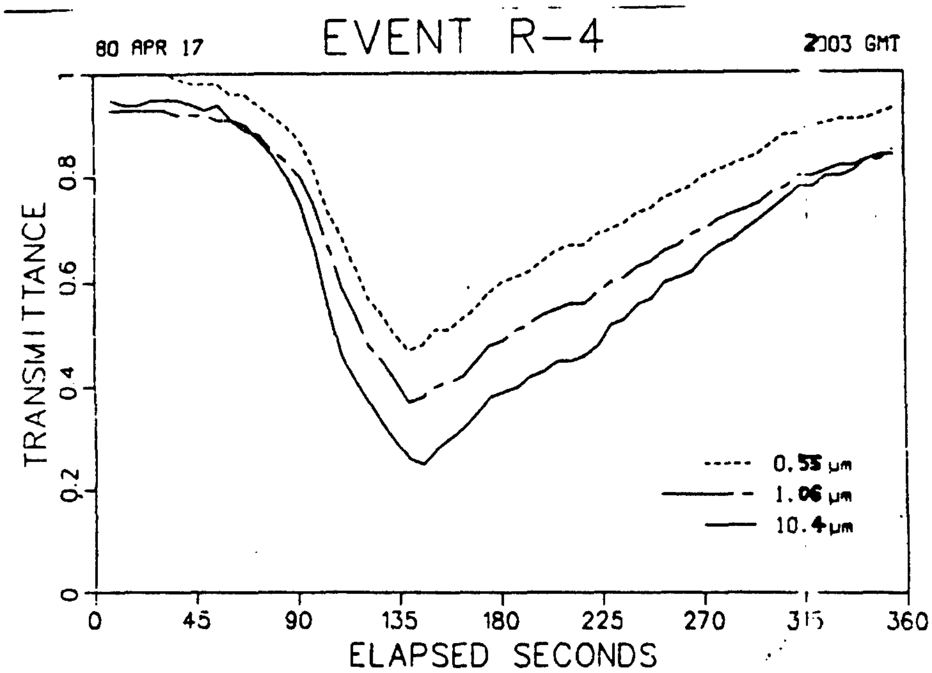

Figure 14. Time scale is expanded during sharp increase and decrease in rain rate. There is distinct separation among the three wavelengths.